

Optical properties and radiative forcing of biomass burning aerosols during the 2019-2020 Australian bushfire season

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Smoke aerosol layers from the extraordinary biomass burning (BB) event in 2019-2020 in Australia were observed with the Cloud- Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellite and analyzed in terms of their optical and radiative properties in different altitudes and regions. The bushfires injected large amounts of smoke particles in the troposphere and stratosphere, found within a longitude range of 140° E to 20° W, in the latitude band of 20°- 60° S, from 25 December 2019 to 12 February 2020.

The optical properties of the BB layers were measured and showed that in the troposphere, particles were found to be nearly spherical, and possibly mixed with marine aerosols at lower heights (particle linear depolarization ratio(pldr)<0.10), while in the stratosphere the particles were more depolarizing with significantly enhanced pldr values that reached up to 0.20. The tropospheric BB aerosols tend to become more spherical, as they move across the South Pacific Ocean, in contrast to the stratospheric aerosols that were getting less spherical through their movement. In the stratosphere fine mode aerosols were measured with Ångström exponent related to backscatter ($\text{\AA}_b$) values of even 3, in contrast to the tropospheric $\text{\AA}_b$ values that indicated the predominance of larger sized particles. In the troposphere a slightly descending trend was visible, showing that the tropospheric smoke particles probably grow in size as they fend off the source, while the stratospheric particles were getting smaller in size.

Sharp changes of carbon monoxide (CO) and ozone (O₃) were also recorded in different atmospheric levels over the study region, showing a moderate correlation between the enhancement of O₃ and CO from the fires. The aerosol radiative forcing of the aerosol layers was well correlated to the aerosol optical depth (aod) of the layers, based both on the R-square values and the slopes of the linear regression lines. Generally, both tropospheric and stratospheric layers had a negative mean effect in each vertical atmospheric level.